encode the actual band position BP_A using a fixed number of bits. For instance, the actual band position BP_A may be one of the 0th to 31st bands and may be encoded using five bits. In detail, when the actual band position BP_A of the current block, for example BL**7**, is the 10th band B**10**, the actual band position BP_A may be encoded into a 5-bit code, e.g., 01010.

**[0077]** The SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF between the actual band position BP_A and the predicted band position BP_P of the current block using variable length coding. In other words, the BP_DIF value represents the difference of the actual band position BP_A and the predicted band position BP_P of the current block. The SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF in a variable number of bits according to the difference value BP_DIF in connection with a variable length coding table, such as the coding table of FIG. **8** but the example embodiments are not limited thereto and may contain other code values and/or number of bit(s) representative of a respective difference value BP_DIF. For instance, referring to FIG. **8**, when the difference value BP_DIF between the actual band position BP_A and the predicted band position BP_P is −1, the SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF into a 2-bit code, e.g., 11. When the difference value BP_DIF between the actual band position BP_A and the predicted band position BP_P is 3, the SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF into a 3-bit code, e.g., 110.

**[0078]** The variable length coding may refer to allocating a variable bit length for coding according to a value to be coded. The variable length coding may be Huffman coding, Lempel-Ziv coding, arithmetic coding, Shannon-Fano coding, exponential-Golomb coding, etc., but is not restricted thereto and may use any suitable coding protocol.

**[0079]** FIG. **9** is a flowchart of a method of operating an encoder according to some example embodiments of the inventive concepts. Referring to FIGS. **4** through **9**, the SAO parameter decision circuit **255-1** of the SAO filter **255** may determine a SAO type for the offset control of a current block. In other words, the SAO parameter decision circuit **255-1** may determine the SAO type as a BO type or an EO type according to the pixel value features of the current block.

**[0080]** When the SAO type is determined as the BO type, the SAO parameter decision circuit **255-1** may determine the offset bands OB of the current block and an offset value for each of the offset bands OB. The SAO parameter decision circuit **255-1** may determine the actual band position BP_A of the current block, which is related to the actual positions of the offset bands OB, in operation S**110**.

**[0081]** The offset bands OB may be consecutive bands that have a desired, improved, and/or optimal rate-distortion cost among a plurality of bands. For example, the predicted band position BP_P may be a band coming first in a direction in which an index increases among the offset bands OB. The SAO parameter decision circuit **255-1** may determine whether there is any actual band position of blocks that have been processed prior to the current block in operation S**120**, e.g., determine if the current block is the first block to be processed or not. When no actual band position of blocks have been processed prior to the current block (e.g., the current block is the first block to be processed), the SAO parameter encoding circuit **248-1** may encode the actual band position BP_A of the current block, which has been determined in operation S**110**, using a fixed number of bits in operation S**150**.

**[0082]** When there one or more actual band position of blocks have been processed prior to the current block (e.g., the current block is the second or later block to be processed), the band position prediction circuit **255-2** may determine a predicted band position of the current block in operation S**130**. In detail, the band position prediction circuit **255-2** may determine at least one of the actual band positions of the previous blocks BL**1** through BL**6** processed prior to the current block BL**7** as the predicted band position BP_P based on the band position table **255-3**. For instance, the band position prediction circuit **255-2** may determine, as the predicted band position BP_P of the current block BL**7**, the actual band position of the fifth block BL**5** is the closest band position to the current block BL**7** in order of processing among the previous blocks BL**1**, BL**3**, BL**4**, and BL**5** that have been processed as the BO type. In other words, the band position prediction circuit **255-2** may determine or choose the 11th band B**11** as the predicted band position BP_P of the current block BL**7**.

**[0083]** Additionally, the band position prediction circuit **255-2** may determine the predicted band position BP_P using a mean value of the actual band positions of the respective previous blocks processed prior to the current block, e.g., the previous blocks may be BL**1** through BL**6** and the current block BL**7** based on the band position table **255-3**.

**[0084]** The SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF between (e.g., the difference value of) the actual band position BP_A and the predicted band position BP_P using variable length coding in operation S**140**. In other words, the SAO parameter encoding circuit **248-1** may encode the difference value BP_DIF using a variable number of bits according to the difference value BP_DIF.

**[0085]** The variable length coding may refer to allocating a variable bit length for coding according to a value to be coded. The variable length coding may be Huffman coding, Lempel-Ziv coding, arithmetic coding, Shannon-Fano coding, exponential-Golomb coding, etc., but is not restricted thereto.

**[0086]** As described above, according to some example embodiments of the inventive concepts, a method of operating an encoder performs prediction of a band position and uses variable length coding, thereby providing a high compression ratio.

**[0087]** The methods according to the above-described example embodiments may be recorded in non-transitory computer-readable media including program instructions to implement various operations of the above-described example embodiments. The media may also include, alone or in combination with the program instructions, data files, data structures, and the like. The program instructions recorded on the media may be those specially designed and constructed for the purposes of some example embodiments, or they may be of the kind well-known and available to those having skill in the computer software arts. Examples of non-transitory computer-readable media include magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD-ROM discs, DVDs, and/or Blue-ray discs; magneto-optical media such as optical discs; and hardware devices that are specially configured to store and